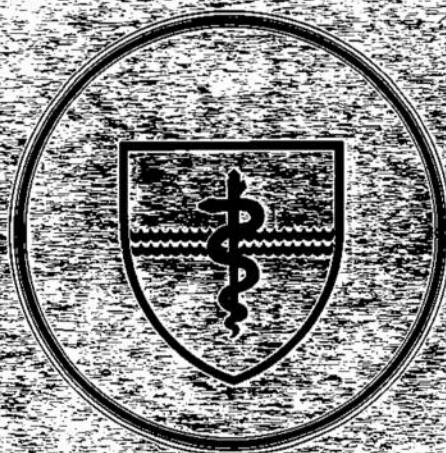


NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

SUBMARINE BASE, GROTON, CONN.



REPORT NUMBER 1096

A Comparison of the Comfort of Seats for Sonarmen

by

Matthew R. Miller and S. M. Luria

Naval Medical Research and Development Command
Research Work Unit M0100.001-1021

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C. A. HARVEY, CAPT, MC, USN

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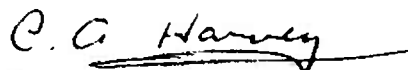
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A handwritten signature in dark ink, appearing to read "C. A. Harvey", with a horizontal line drawn underneath the name.

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SUMMARY PAGE

PROBLEM

To rate the suitability of various seating designs for sonar operators.

FINDINGS

Sonarmen undergoing refresher training in the Sonar Operational Trainer compared and rated a standard office chair, a standard office chair with an inflatable lumbar pillow, a highly contoured seat with an adjustable backrest taken from an automobile, and a forward-sloping chair for comfort. The ability to carry out their sonar duties while sitting in these chairs, and the overall desirability of these chairs for the sonar room was evaluated. The car-seat was the most highly rated chair and the forward-sloping chair the lowest. The lumbar pillow was a unanimously preferred addition to the standard office chair. Additional comments indicated that the ideal sonar chair would swivel, have an adjustable seat-height, a well contoured, adjustable backrest, armrests, and a lumbar support.

APPLICATION

These findings are relevant to the design of improved seats for sonarmen.

ADMINISTRATIVE INFORMATION

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A Comparison of the Comfort of Seats for Sonarmen

Matthew R. Miller and S. M. Luria
Naval Submarine Medical Research Laboratory

Abstract

Sonarmen undergoing refresher training in the Sonar Operational Trainer compared, while on "sonar watch," the comfort of four seating designs: a contoured automobile seat with an adjustable backrest; a "kneeling" chair; a conventional office chair with an inflatable lumbar support pillow; and a conventional office chair. The subjects were asked to use each seat for an entire day --unless it was too uncomfortable-- and to use a different seat on successive days. The automobile seat was judged to be the most comfortable. It was concluded that significant improvements can be made in the design of the seats on submarines.

Introduction

The design of chairs has received a great deal of attention in recent years. One source of this renewed interest has been the widely publicized complaints of excessive fatigue and assorted pains and symptoms by individuals who use video display terminals (VDTs). A study by the National Academy of Sciences concluded that VDTs do not emit harmful radiation (Brown, et al 1982), and a number of subsequent articles asserted that most of the complaints could be attributed to poor design of the work stations (Kroemer and Hill, 1986; Polakoff, 1986; Reynolds, 1986).

One area which was said to be poorly designed was the chair, which, as one authority put it, "is perhaps the most important and most overlooked item in the modern office (Thompson, 1985). A 1984 survey of VDT users in New York State government departments found that complaints about chairs outnumbered all other complaints (Menke, 1986). Indeed, the need to carefully design chairs appears to be overlooked in most situations, for there have been several reports which have been critical of the quality of seats even in helicopters (Shanahan and Reading, 1984; Beach, 1985).

That criticism notwithstanding, a number of studies have attempted to specify the optimal design of chairs and work-stations, primarily for clerical occupations, of course (e.g., Barkla, 1964; Mandal, 1982; Life and Pheasant, 1984; Grandjean, et al, 1984; Branton, 1984; Corlett and Eklund, 1984). The interest in chair design has led to attempts to devise methods of evaluating them (Shackel, et al 1969; Drury and Coury, 1982) and innovative new designs. Beach (1985) noted that the most common criticisms were lack of adjustability of seat height, improper angle of the seat back, and lack of adequate lumbar and buttock support. One innovation, therefore, is a lumbar pillow which is inflated by the user to the shape which feels most comfortable. Beach (1985) recommended that these should be used on helicopter seats. Another innovation that has attracted a great deal of attention is the forward sloping chair (Mandal, 1981; Anon., 1976), but a recent evaluation reported mixed results (Drury and Francher, 1985).

Although there have been far more published complaints about, for example, helicopter and tractor seats (Donati, et al, 1984), sonarmen (and other submariners who spend their watches sitting) have also complained about the lack of comfort of the seats (Miller, 1986). We have, therefore, obtained subjective comfort ratings for three novel seats and compared them with the ratings for a standard office chair.

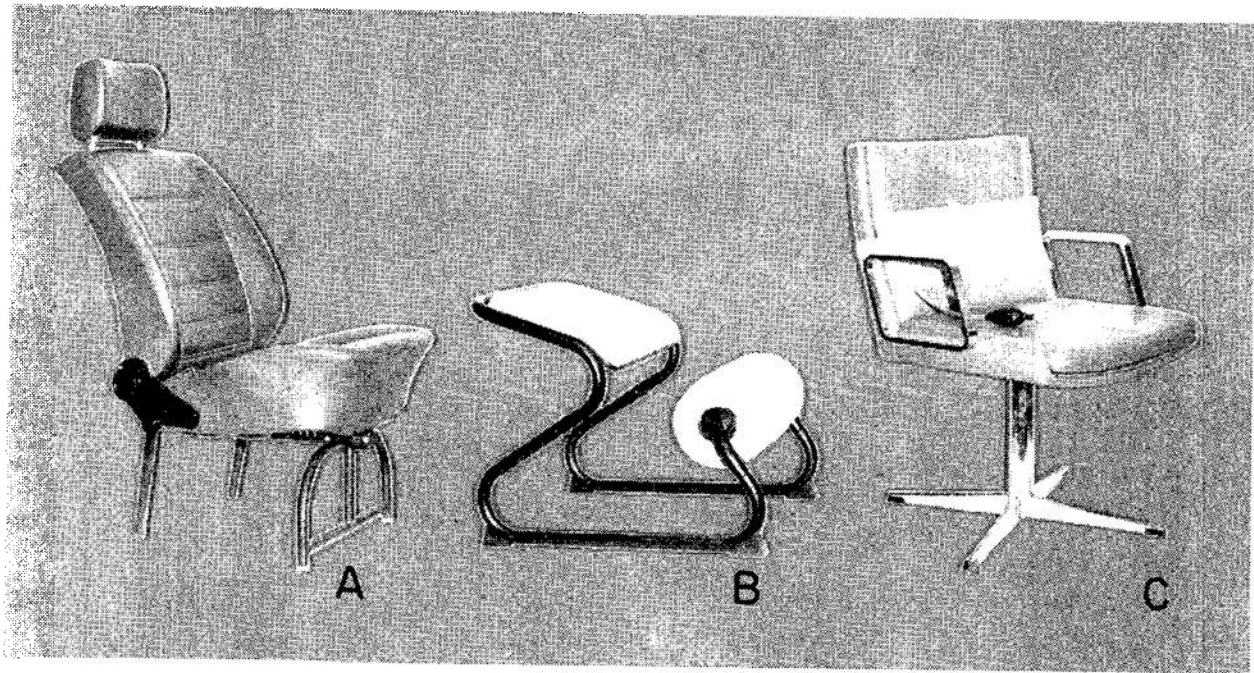


Figure 1. The test seats. (a) Automobile seat, (b) "Kneeling chair", (c) Conventional seat with inflatable lumbar pillow attached to the back.

Subjects were assigned a chair to sit in for the entire day, and they rated the chair at the end of the day. Such ratings are often obtained after a much shorter exposure. Barkla (1964) claimed that subjects reported different comfort ratings between chairs after 30 minutes of exposure. Shackel et al (1969) found that significant differences in comfort ratings appeared almost immediately; but as the exposure duration continued, further differences appeared. Donati et al (1984) used an exposure time of 30 minutes. This is probably not a particularly short experimental duration when several chairs are being compared. Drury's subjects sat in their experimental chairs for 2.5 hours (Drury and Coury, 1982). Other studies such as those by Drury and Francher (1985) and Shanahan and Reading (1984) used a total exposure time of 2 hours.

The evaluations in the present study were made while the subjects were engaged in the same tasks they performed at sea, with the same equipment, and in a compartment which was a mock-up of a sonar room on a submarine.

METHOD

Subjects

Thirty-six active duty U.S.N. sonarmen, undergoing refresher training in the Sonar Operational Trainer, volunteered to serve as subjects.

Chairs

Three experimental chairs, as well as the standard office chair, were tested (Figure 1). One was an automobile "bucket-seat" with an adjustable backrest which was placed on a set of legs, raising it to the height of the standard office chair (46 cm; 18 in). The second was a "kneeling chair". The third was a standard office chair which had an inflatable lumbar pillow attached to the back (each subject inflated the pillow to the extent most comfortable for him). These were compared to a conventional office chair.

Procedure

It was hoped that the sonar crews would be at the trainer for an entire week, but this was true for only one crew. Men were assigned randomly to the three experimental seats at the beginning of the day and requested to use that seat for the entire day. They were, however, told that they could abandon a chair at any time if it proved to be too uncomfortable and replace it with a standard chair. Only six subjects remained in the trainer long enough for each man to evaluate each of the chairs on successive days, and another 30 men evaluated only one chair; 7 rated the automobile seat, 5 the kneeling chair, 6 the lumbar pillow, and 12 the conventional chair. At the end of each day, the men filled out a short questionnaire giving their opinion of the chair they had used on that day. Those men who remained for the entire week also filled out a final questionnaire comparing the four chairs.

RESULTS

The subjects rated the chairs on a scale of 1 (poor) to 5 (good) for comfort, ease of carrying out the required duties in the chair, and overall desirability for the sonar room. Figure 2 shows the mean ratings of each chair. These are given separately for the six subjects who evaluated all four chairs and for the 30 subjects who evaluated only one of the three experimental chairs.

The conventional seat received the highest rating for comfort and also scored very well for ease of working and overall desirability. The car-seat was also rated highly by both groups on all three counts. The lumbar pillow was given the lowest rating by both groups for ease of carrying out their duties, but the kneeling chair was rated as least desirable overall. When the ratings for the two groups were combined, the ratings of comfort and overall desirability were significantly different ($p < .05$) for the chairs, according to the Kruskal-Wallis test.

The men who had sat in all the chairs filled out a paired-comparison evaluation at the end of the week. Table 1 shows the percentages of preferences for each seat being compared to the other seats. Despite the fact that the conventional seat was rated very highly, it fared much less well on the paired-comparisons. It received only 19% of the preferences compared to 43% for the car-seat, 27% for the lumbar pillow, and 11% for the kneeling chair. Compared to the standard seat, 15% of the responses preferred the car-seat, 13% preferred the lumbar pillow, and only 4% preferred the kneeling chair. The total percentage of responses preferring the car-seat was 43% compared to only 11% for the kneeling chair. The standard chair with the lumbar pillow was preferred to the standard chair without the pillow by a margin of 27% to 19%.

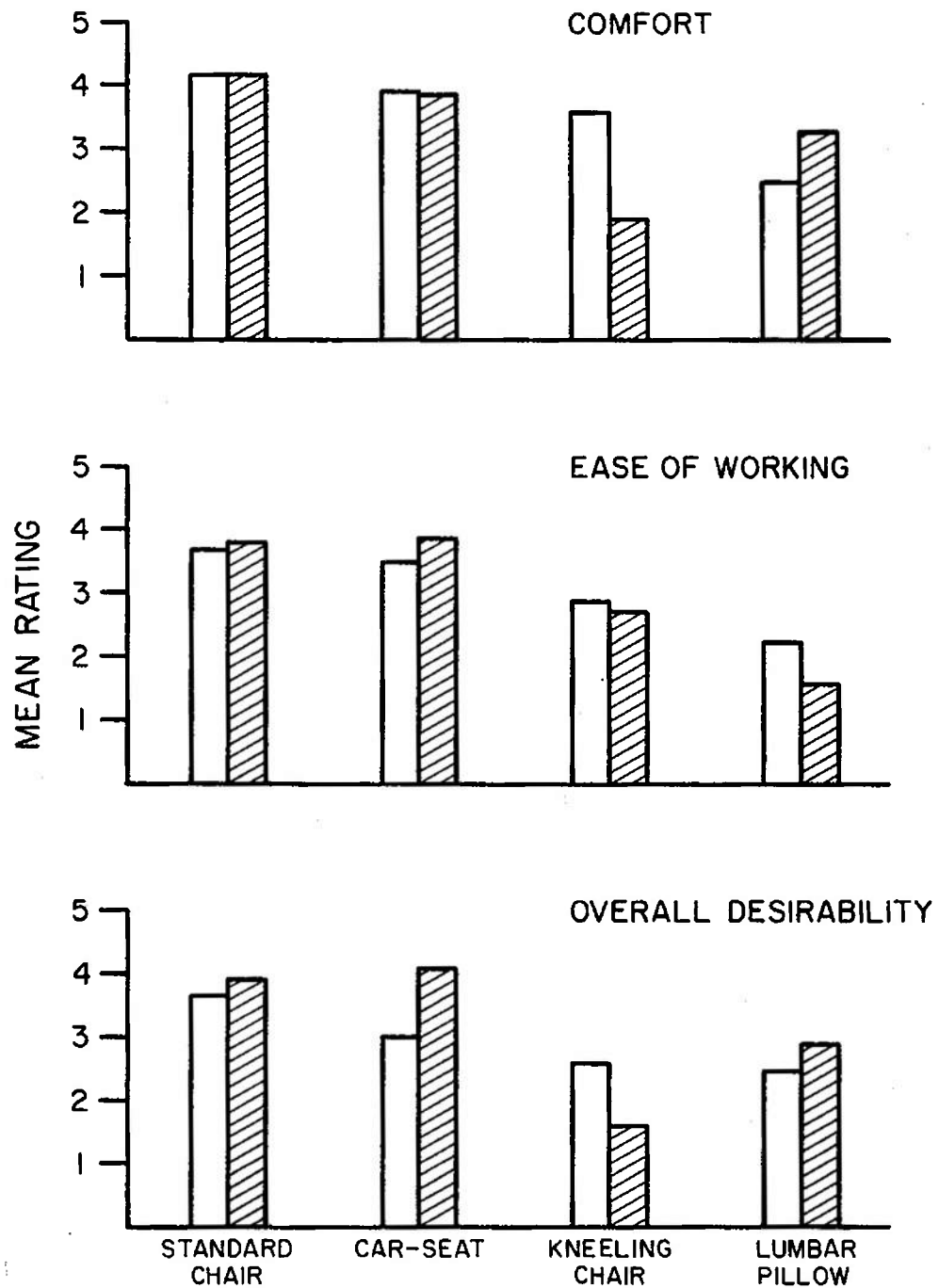


Figure 2. The mean ratings for each seat for comfort, ease of carrying out assigned duties, and overall desirability (1 = poor; 5 = good). The unshaded bars give the mean ratings for those subjects who evaluated all seats; the shaded bars give the mean ratings for the subjects who evaluated only one of the seats.

TABLE 1. Percentages of preferred seats in paired-comparison test

| | Preferred Seat | | | |
|-------------------|-----------------|----------|----------------|---------------|
| | Standard office | Car seat | Kneeling chair | Lumbar pillow |
| Comparison Office | - | 15 | 4 | 13 |
| Car | 2 | - | 2 | 3 |
| Kneel | 13 | 14 | - | 11 |
| Pillow | 4 | 14 | 5 | - |
| Total | 19 | 43 | 11 | 27 |

DISCUSSION

The car-seat was the most popular seat in this group, both according to the paired-comparisons and to remarks made by the subjects at the end of the sessions. There were very few instances of another seat being preferred to it. The high ratings given to the conventional chair may have resulted simply from the fact that it is a familiar and generally unobjectionable chair. But when asked to compare it with the car-seat, only 2% of the subjects preferred the car-seat. The greatest criticism of the car-seat was the lack of arm-rests; had it also had arm-rests, the margin of preference would have been even greater.

Another shortcoming of all the seats was that there was no adjustment for the height of the seat. It was set at the standard height for office chairs. Mandal (1982) has made the unsurprising observation that the proper height of the seat depends on the height of the individual, and the standard height may not be correctly set. Although this observation must be completely obvious, adjustable seat-heights are by no means always available.

What apparently made the car-seat the most popular was that the backrest is much more satisfactorily contoured than the typical chair, and that it is also adjustable. One subject wrote, "The car seat was the first sonar seat that didn't cut me in the middle of the back."

Despite the various analyses that show that the forward sloping chair is more conducive to correct posture and produces less strain on the back (Mandal, 1981), this chair was not favorably received. As Drury and Francher (1985) concluded from their evaluation, "Overall, the chair was no better than conventional chairs and could be worse than well-designed conventional office chairs." Several subjects felt that this chair was comfortable for short periods of time ("no more than one hour"), but not for a complete submarine watch-period of six hours. "Starts out comfortable," wrote one subject, "but the longer you sit on it the less comfortable it becomes." Sonarmen typically move from one sonar position to another every hour, but they are, of course, moving from one seat to another one identical to it. Corlett and Eklund (1984) noted that a negative aspect of the kneeling seat is that "the sitter is intrinsically unstable." and, in fact, one subject wrote that the "difficulty of maintaining balance during sharp maneuvers could prove dangerous to the user."

The primary reason for downgrading the inflatable lumbar pillow was that it was too delicately manufactured; the opinion was widely shared that it would not last long. Of course, such a device can be made more sturdy. In the paired-comparisons everyone preferred the standard chair with the lumbar pillow to the chair without it.

SUMMARY

Well designed seats are much to be desired on submarines. As one subject wrote, "Standing watches can be more fatiguing than driving long distances at night with headlights shining in your eyes." Although one subject wrote, "Chairs presently on 688s are excellent," another one commented that the "car-seat is better than seats on submarines."

The ratings indicate that a standard seat is improved when an adjustable lumbar support is added, but the well-contoured car-seat with its adjustable backrest is better yet.

Taking into account the additional comments, it appears that the ideal seats would be better contoured than conventional seats, would swivel, have armrests, and adjustable seat-heights, backrests, and lumbar supports.

Interestingly, more than one subject expressed doubt that a perfectly comfortable chair would be most desirable. As one put it, "A very comfortable chair is not desirable-- it may lull you to sleep." Preliminary tests in the sonar trainers should indicate whether or not such seats would lull the operators to sleep.

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